Conjugated Block Copolymers for Organic Photovoltaics and Flexible Battery Cathodes

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Block copolymer self-assembly is a powerful approach to control the microstructure of polymeric materials. Here, we demonstrate the development of conjugated block copolymers for use as the active layer in organic photovoltaic devices and flexible cathodes for energy storage. All-conjugated block copolymers with donor and acceptor blocks linked covalently can be used in the active layer of solution processed photovoltaics. These materials self-assemble to form nanostructured, bicontinuous donor and acceptor domains, and the microstructure of solution-processed films is comprehensively characterized by grazing-incidence X-ray scattering. We show that the photovoltaic performance of these block copolymer devices depends on the characteristic domain sizes, crystalline orientation, and the linking group between donor and acceptor groups, and our work suggests that enhancing the segregation between donor and acceptor domains can further increase efficiencies. Block copolymers with one conjugated polymer block and an ion-conductive block can be applied as binders in battery cathodes. Blends of V_2O_5 as a lithium intercalation material and 5-10 wt % poly(3-hexylthiophene)-block-poly(ethyleneoxide) (P3HT-b-PEO) block copolymer form a flexible, volumetrically stable, carbon free hybrid battery cathode. X-ray measurements show that the PEO block intercalates between the V_2O_5 layers. Introduction of the block copolymer significantly enhances mechanical flexibility and toughness without significant loss in electrochemical properties.